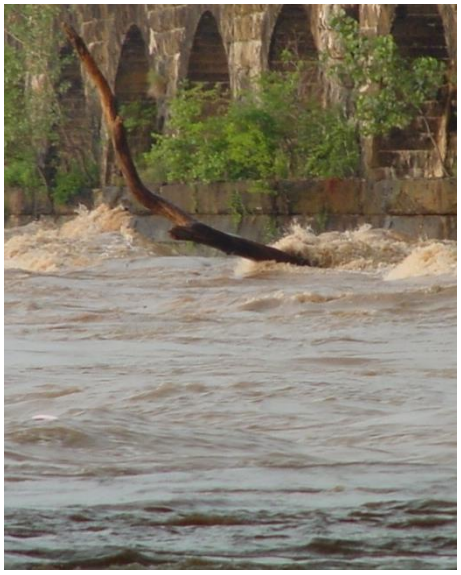
Delaware River Basin Commission

Water Resource Management

Amy L. Shallcross, PE
Manager,
Water Resource Operations

PA AWWA
Spring Joint Technical Conference
March 16, 2017



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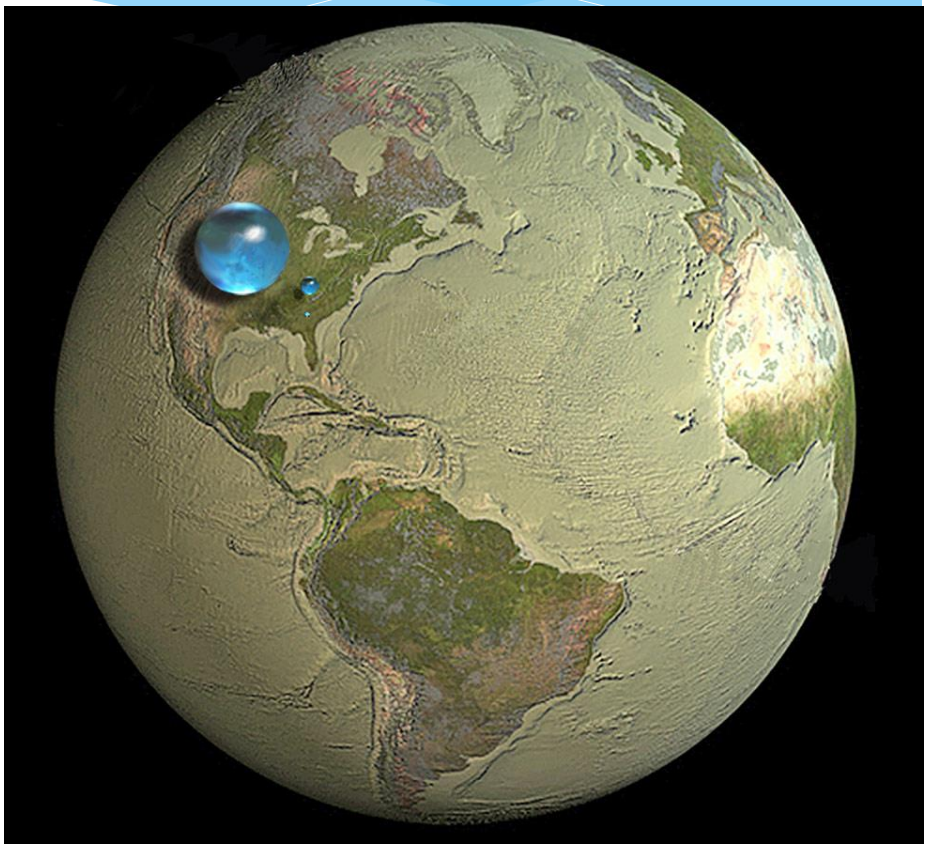
Our Water Resources are FINITE!

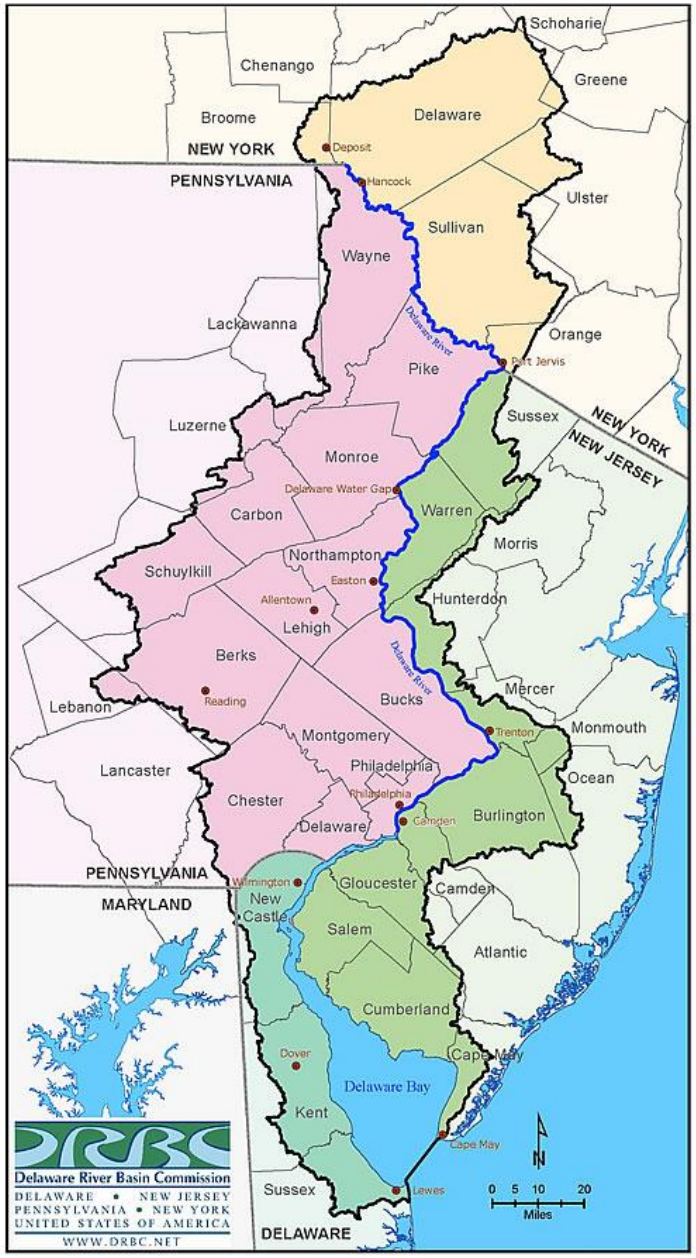
FRESH WATER

Spheres showing:
(1) All water (sphere over western U.S., 860 miles in diameter)
(2) Fresh liquid water in the ground, lakes, swamps, and rivers (sphere over Kentucky, 169.5 miles in diameter), and
(3) Fresh-water lakes and rivers (sphere over Georgia, 34.9 miles in diameter).
Credit: Howard Perlman, USGS; globe illustration by Jack Cook, Woods Hole Oceanographic Institution (©); Adam Nieman.



Water Resource Management

* Water Quantity/**Flow Management**
  * Allocations – Conservation
  * **Storage – Drought and Flood Mitigation**
  * **Low Flow Augmentation**
  * **Flow Objectives**
* Water Quality
  * Monitoring and Assessment
  * Permitting
  * Standards



Delaware River Basin

* Main Stem is 330 miles – no dams
* Forms interstate boundaries for DE, NJ, PA, NY
* 15 million people - 5 percent of the US population
* Drains 13,539 sq. mi. - 0.4 percent of US land area
* Contributes 21 BG in economic value to the region
* 8,280 mgd in SW and GW withdrawals
* 886 mgd consumptive use (11 percent evaporated or exported)

Competing Objectives


EDITORIAL PAGE

PHILADELPHIA RECORD

The War in Outline :: America Speaks :: Travel SUNDAY, MARCH 14, 1937 Screen :: Stage :: Music :: Art :: Radio :: Puzzles

WATER, WATER EVERYWHERE, BUT NOT A DROP FIT TO DRINK

SCHUYLKILL

CHLORINE

PHILADELPHIA

DELAWARE RIVER

E. D. Wilson

* Drinking Water
* Aquatic Resources
* Assimilative Capacity
* Power generation
* Recreation
* Flood Mitigation

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Sources of Water

* Decree
* DRBC Storage in USACE Reservoirs
* Emergency
* Consumptive Use Make –Up
* Dockets

In very dry periods, flow at Trenton can be 60 percent or more from reservoir releases

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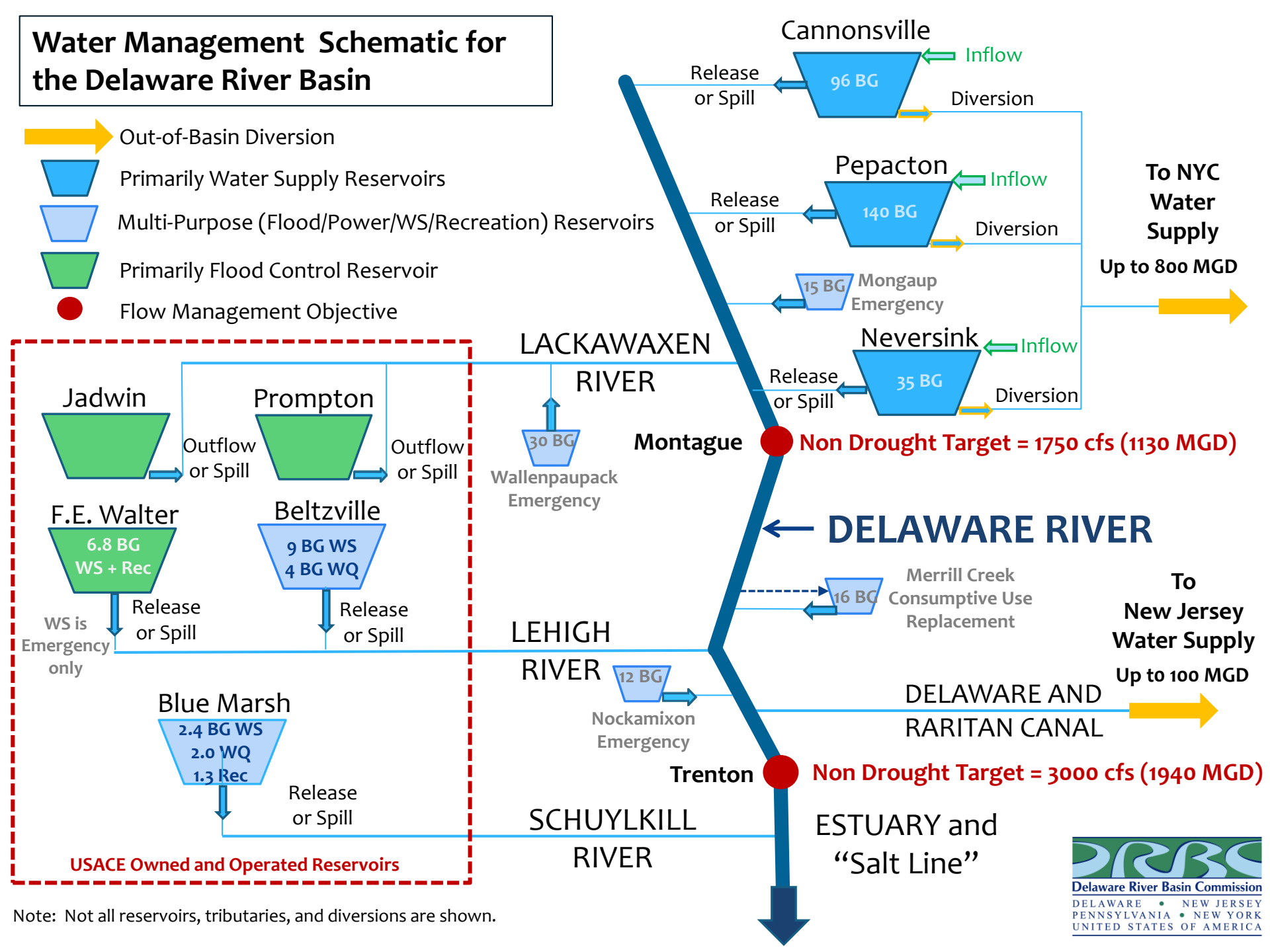
Water Management Schematic for the Delaware River Basin



Note: Not all reservoirs, tributaries, and diversions are shown.

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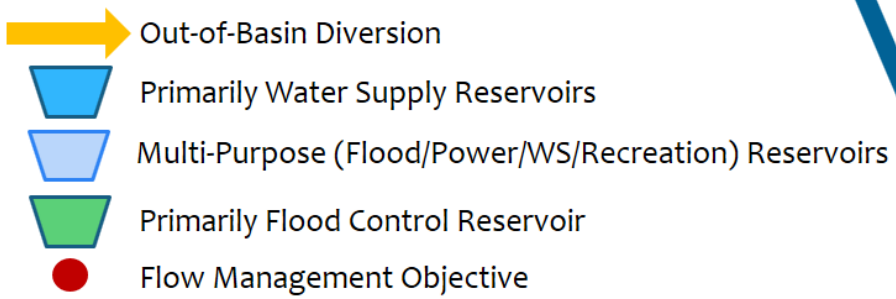

WEST BRANCH DELAWARE RIVER

EAST BRANCH DELAWARE RIVER

MONGAUP RIVER

LACKAWAXEN RIVER

NEVERSINK RIVER

IN THE BEGINNING

DELAWARE RIVER

LEHIGH RIVER

SCHUYLKILL RIVER

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Water Management Schematic for the Delaware River Basin

- Out-of-Basin Diversion
- Primarily Water Supply Reservoirs
- Multi-Purpose (Flood/Power/WS/Recreation) Reservoirs
- Primarily Flood Control Reservoir
- Flow Management Objective

WEST BRANCH DELAWARE RIVER

EAST BRANCH DELAWARE RIVER

MONGAUP RIVER

NEVERSINK RIVER

← **DELAWARE RIVER**

DELAWARE AND RARITAN CANAL (1834)

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1905: NEW YORK CITY LOOKS WEST FOR MORE WATER

← DELAWARE RIVER

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1905: NEW YORK CITY LOOKS WEST FOR MORE WATER

1915: CATSKILL SYSTEM completed but not enough

1927: DELAWARE BASIN Reservoirs approved by NYC Board of Water Supply

1931: NYC sued by NJ (PA and DE Intervened) settled by SCOTUS

DELAWARE AND RARITAN CANAL (1834)

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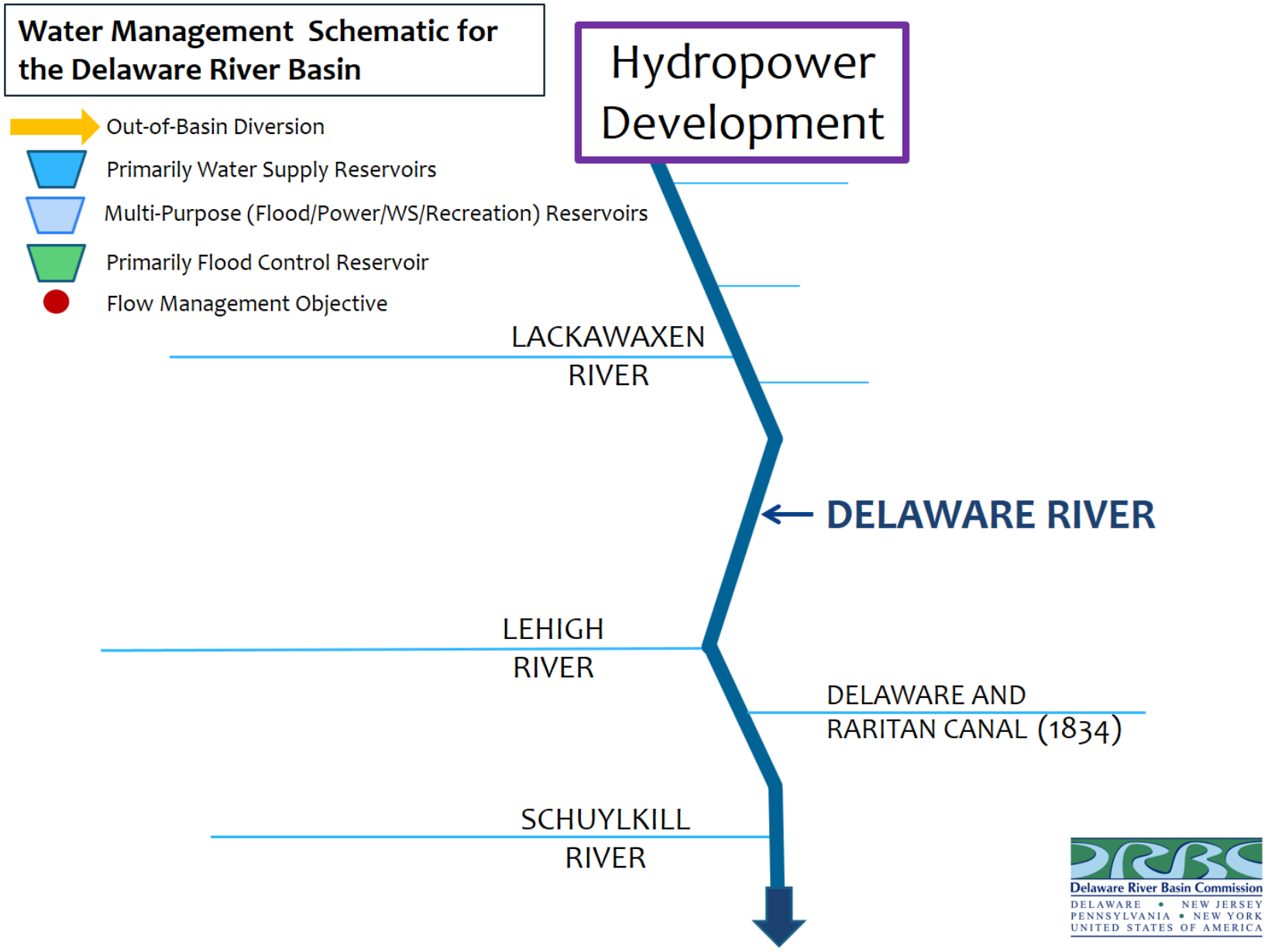
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Hydropower Development
LACKAWAXEN RIVER
DELAWARE RIVER
LEHIGH RIVER
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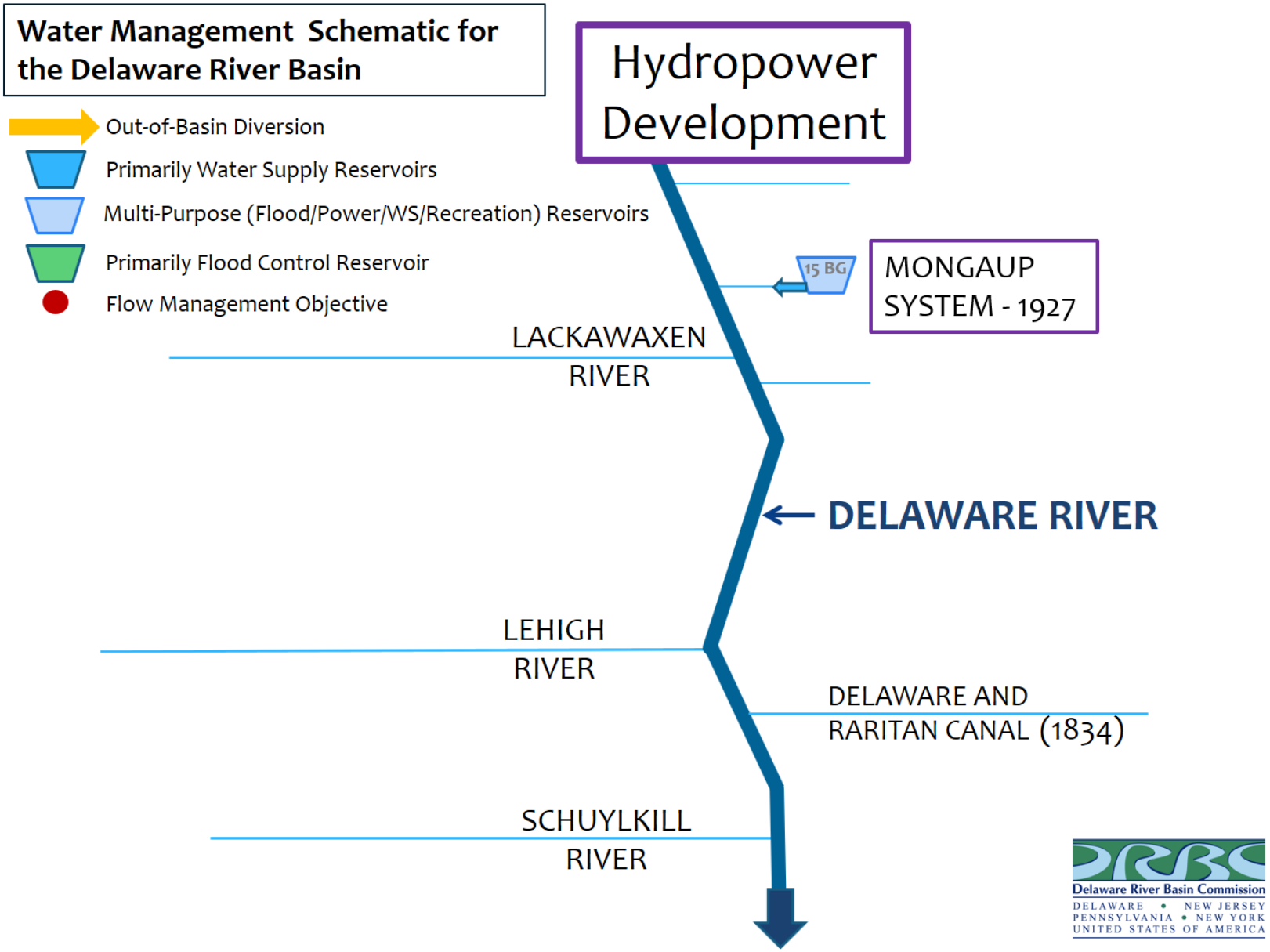
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Flow Management Objective
Hydropower Development
15 BG
MONGAUP SYSTEM - 1927
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Primarily Flood Control Reservoir

Flow Management Objective

Hydropower Development

15 BG

MONGAUP SYSTEM - 1927

LACKAWAXEN RIVER

LAKE WALLENPAUPACK - 1929

30 BG

DELAWARE RIVER

Photo: Talen Energy

DELAWARE AND RARITAN CANAL (1834)

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Flow Management Objective

Hydropower Development

DELAWARE AQUEDUCT COMPLETED IN 1945

To NYC Water Supply

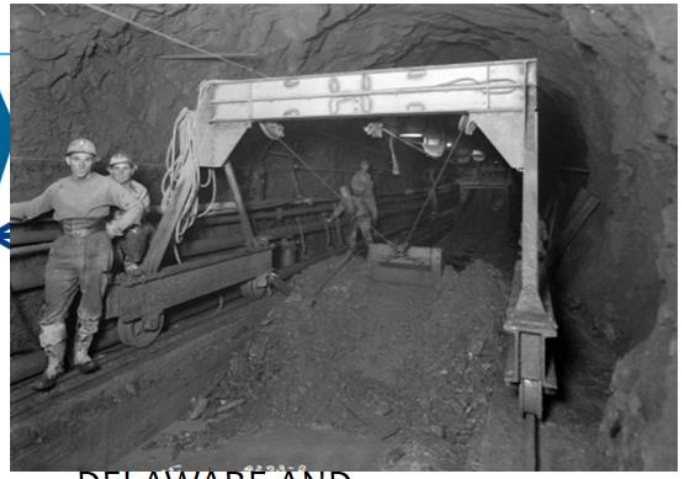
15 BG

MONGAUP SYSTEM - 1927

LACKAWAXEN RIVER

LAKE WALLENPAUPACK - 1929

30 BG



DELAWARE AND RARITAN CANAL (1834)

Photo: Talen Energy

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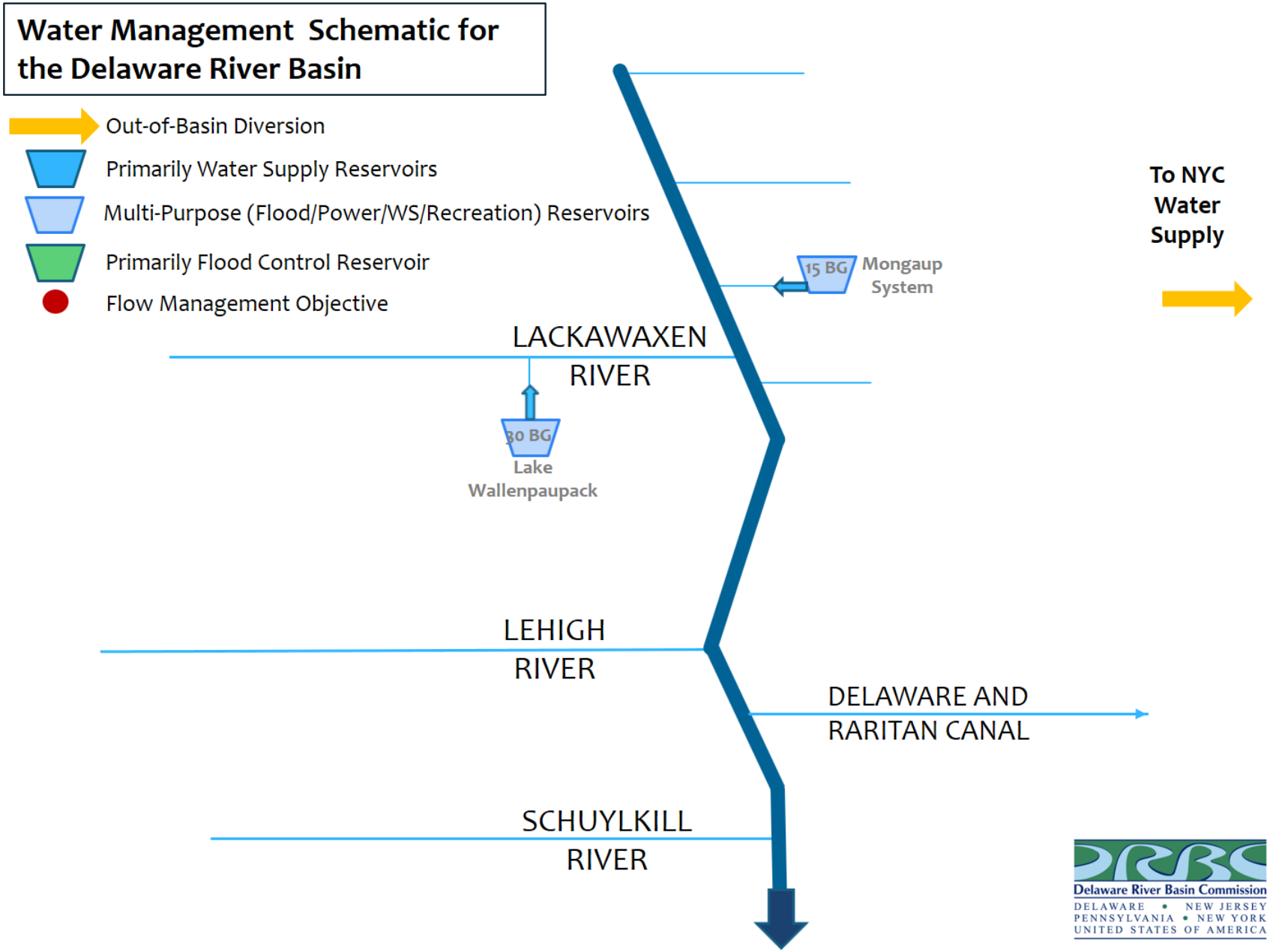

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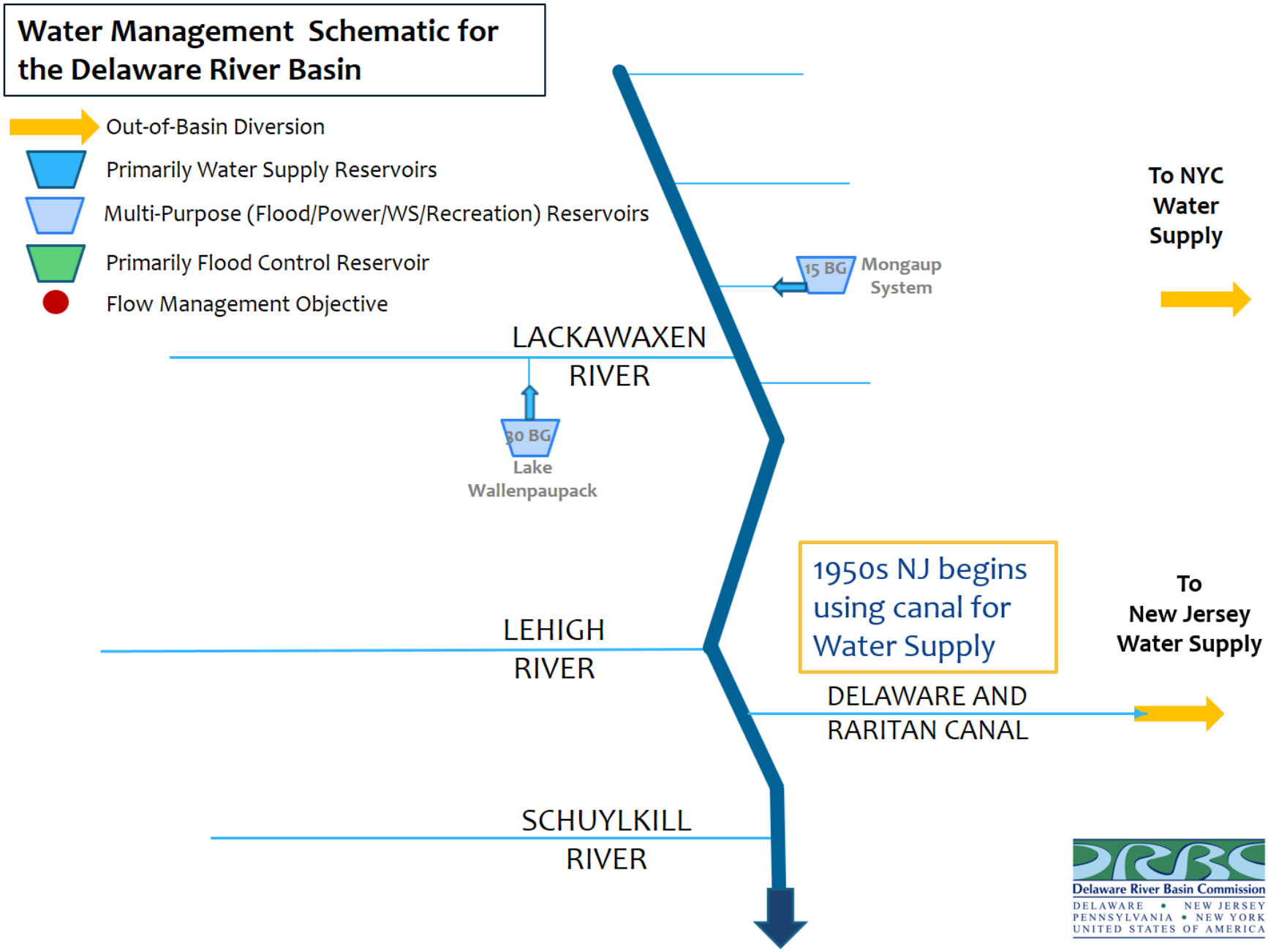
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To NYC Water Supply
15 BG
Mongaup System
LACKAWAXEN RIVER
30 BG
Lake Wallenpaupack
1950s NJ begins using canal for Water Supply
To New Jersey Water Supply
LEHIGH RIVER
DELAWARE AND RARITAN CANAL
SCHUYLKILL RIVER
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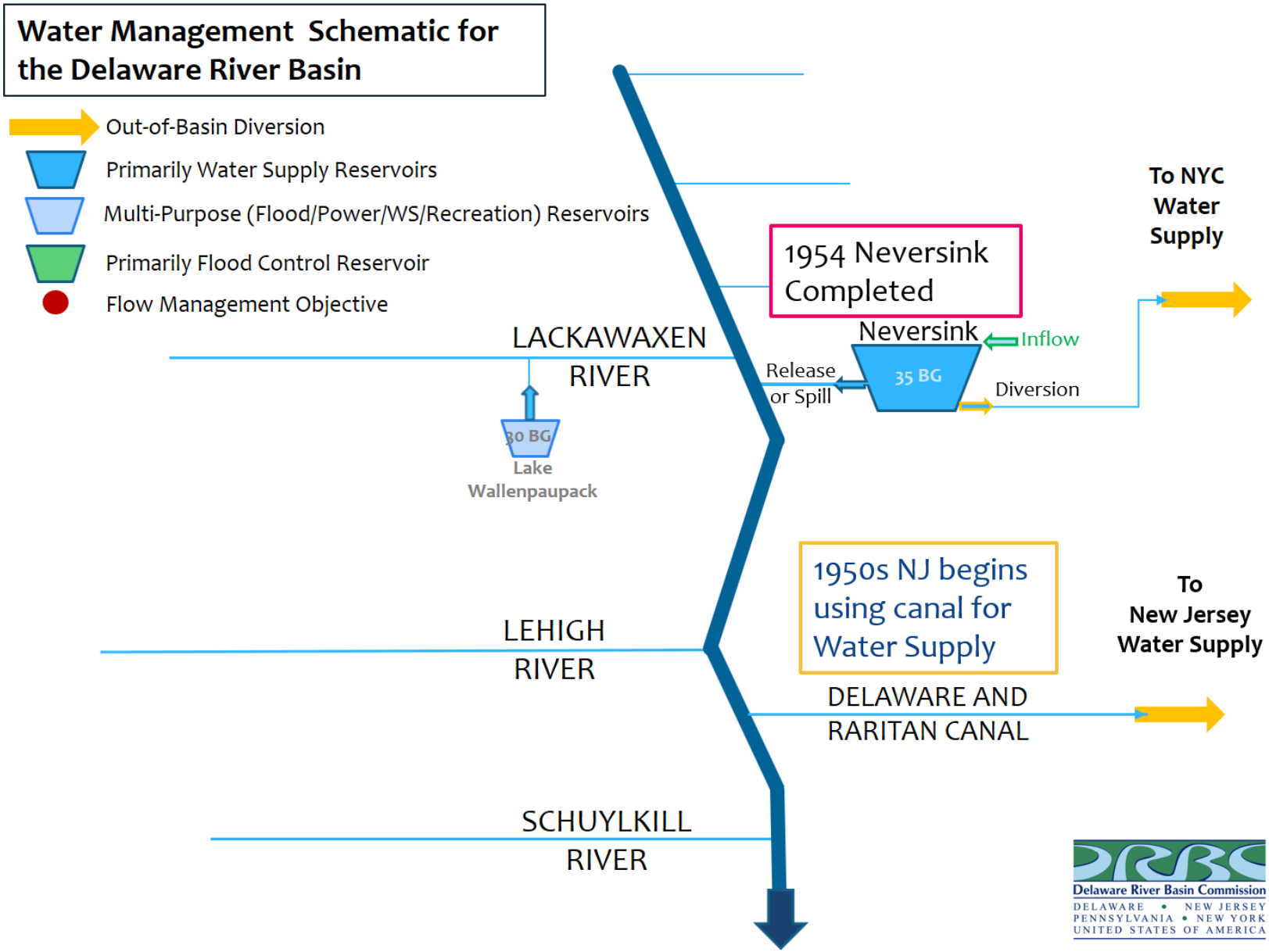
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Primarily Flood Control Reservoir
Flow Management Objective
To NYC Water Supply
1954 Neversink Completed
Neversink
Inflow
35 BG
Release or Spill
Diversion
LACKAWAXEN RIVER
30 BG
Lake Wallenpaupack
1950s NJ begins using canal for Water Supply
To New Jersey Water Supply
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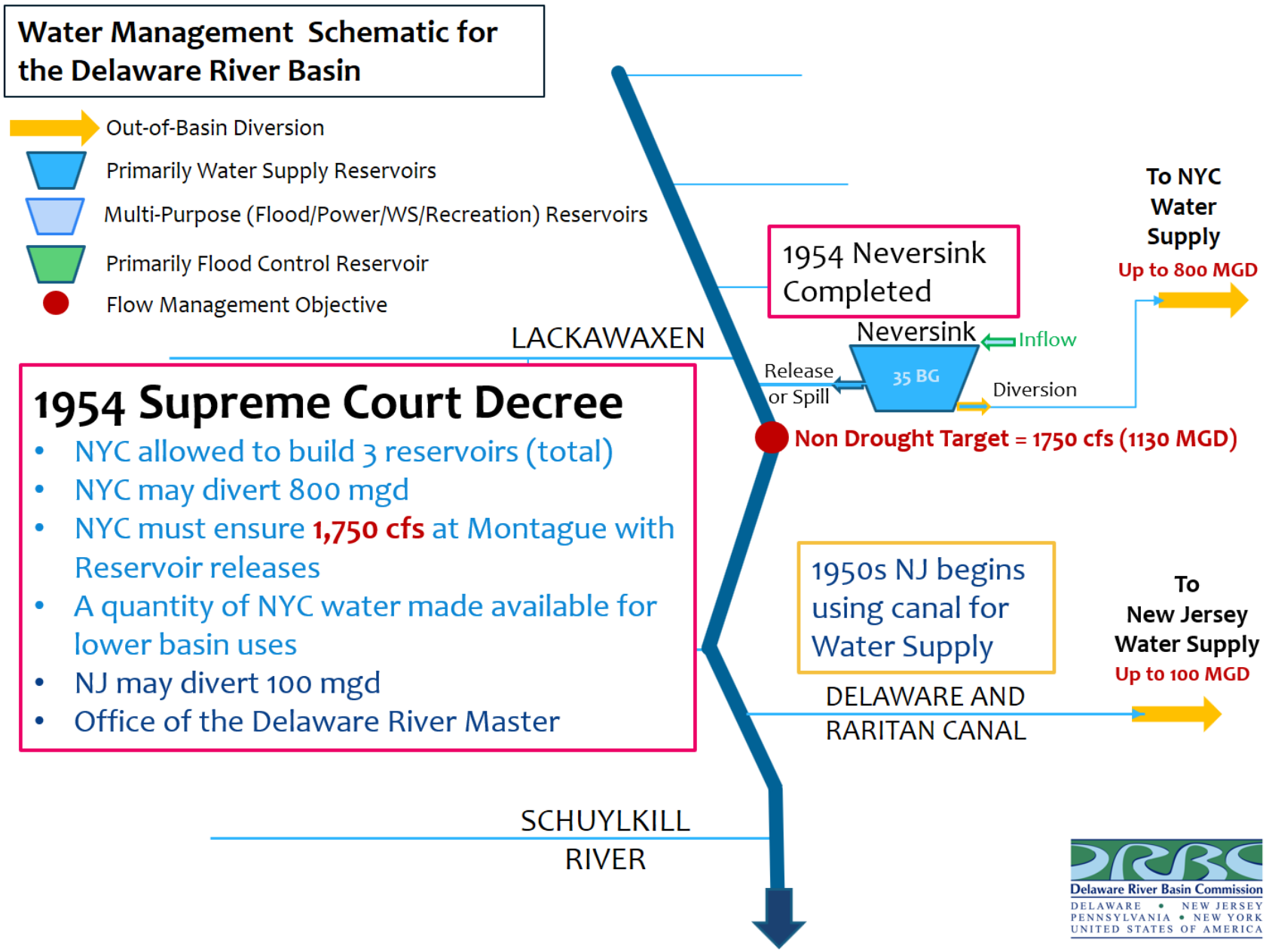

1954 Supreme Court Decree

- NYC allowed to build 3 reservoirs (total)
- NYC may divert 800 mgd
- NYC must ensure **1,750 cfs** at Montague with Reservoir releases
- A quantity of NYC water made available for lower basin uses
- NJ may divert 100 mgd
- Office of the Delaware River Master

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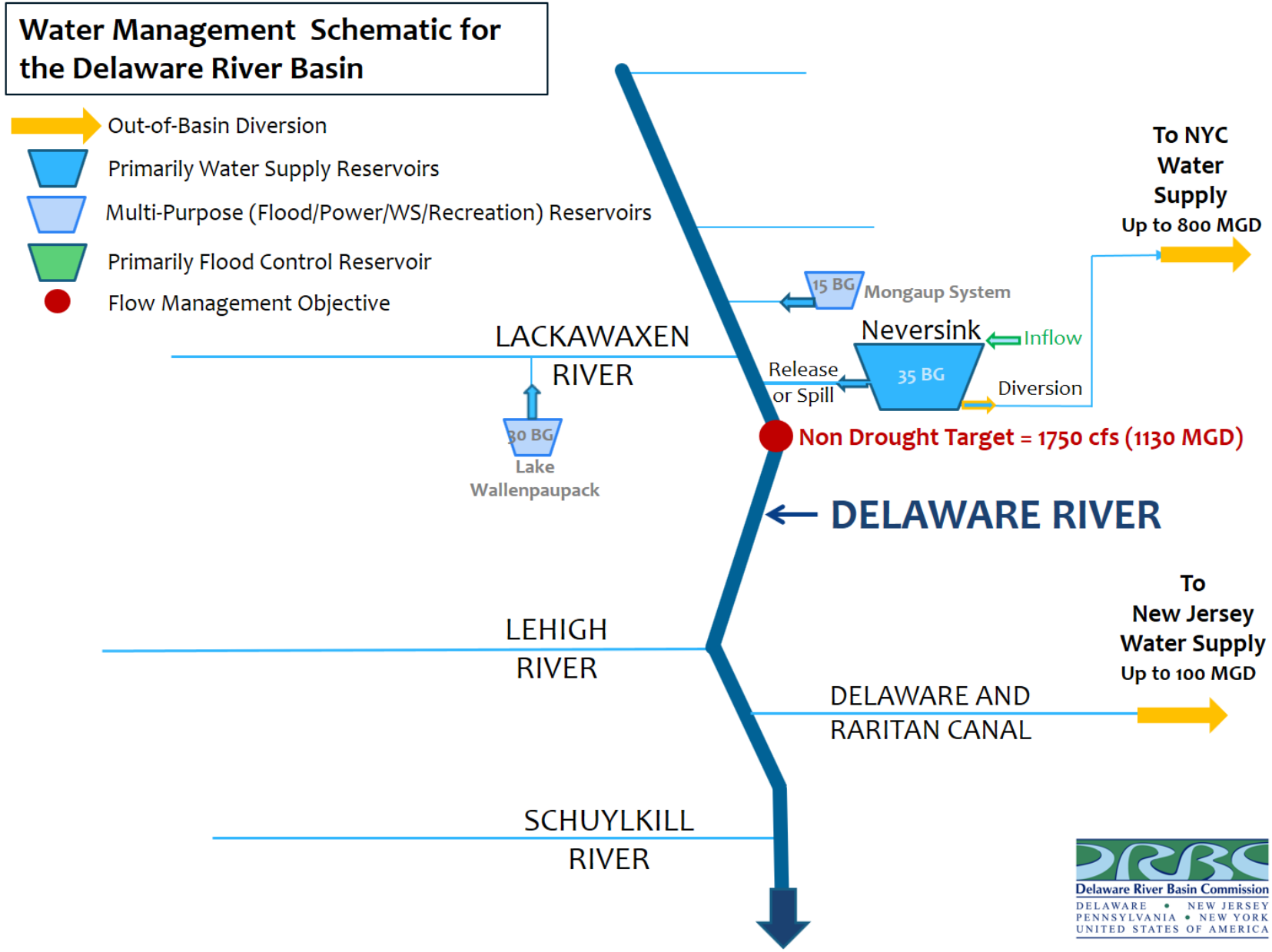

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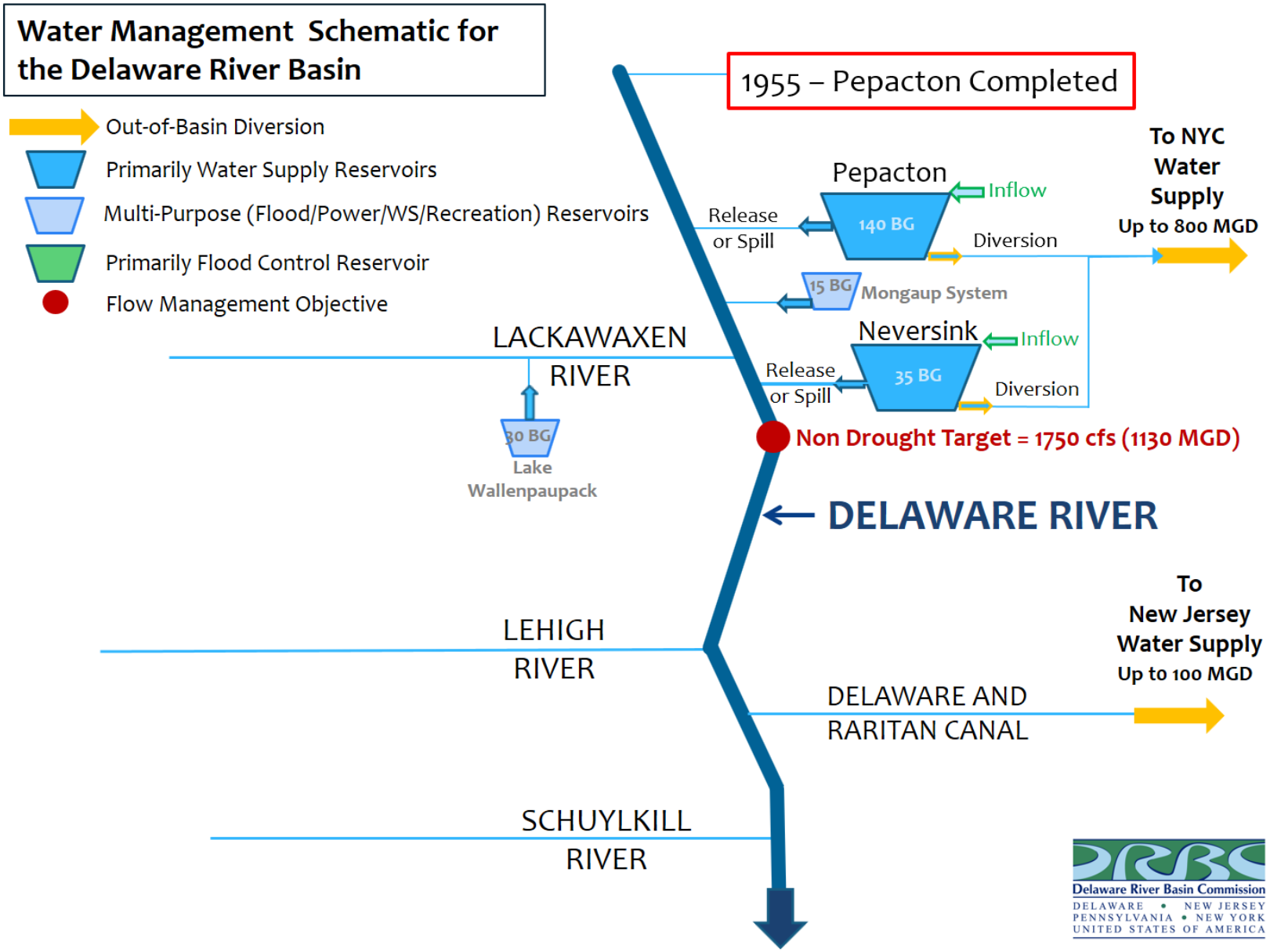
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Flow Management Objective
1955 – Pepacton Completed
To NYC Water Supply
Up to 800 MGD
Pepacton
Inflow
Release or Spill
140 BG
Diversion
15 BG
Mongaup System
Neversink
Inflow
Release or Spill
35 BG
Diversion
LACKAWAXEN RIVER
30 BG
Lake Wallenpaupack
Non Drought Target = 1750 cfs (1130 MGD)
DELAWARE RIVER
To New Jersey Water Supply
Up to 100 MGD
LEHIGH RIVER
DELAWARE AND RARITAN CANAL
SCHUYLKILL RIVER
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Hurricane Diane

1955 Flood

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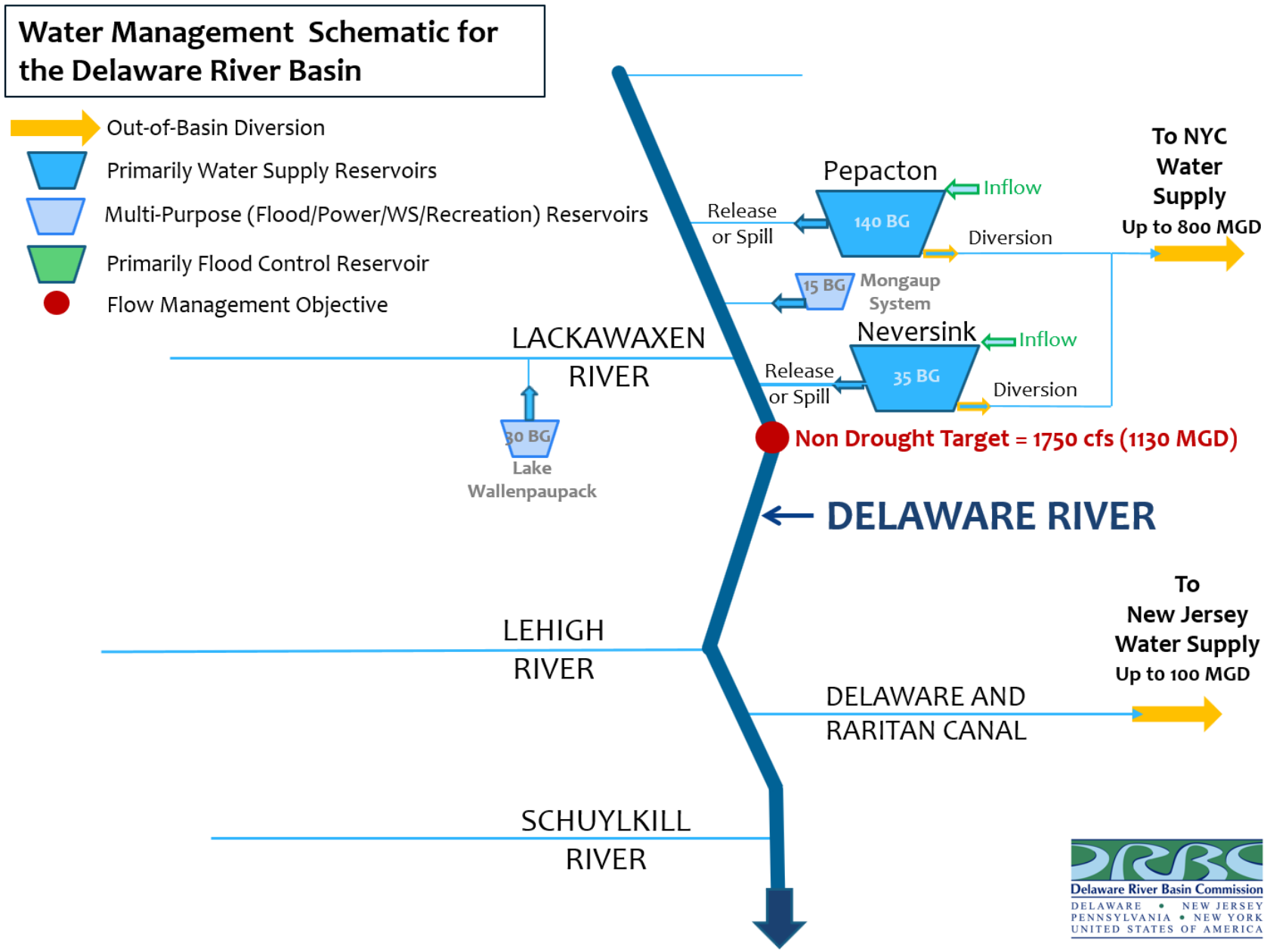

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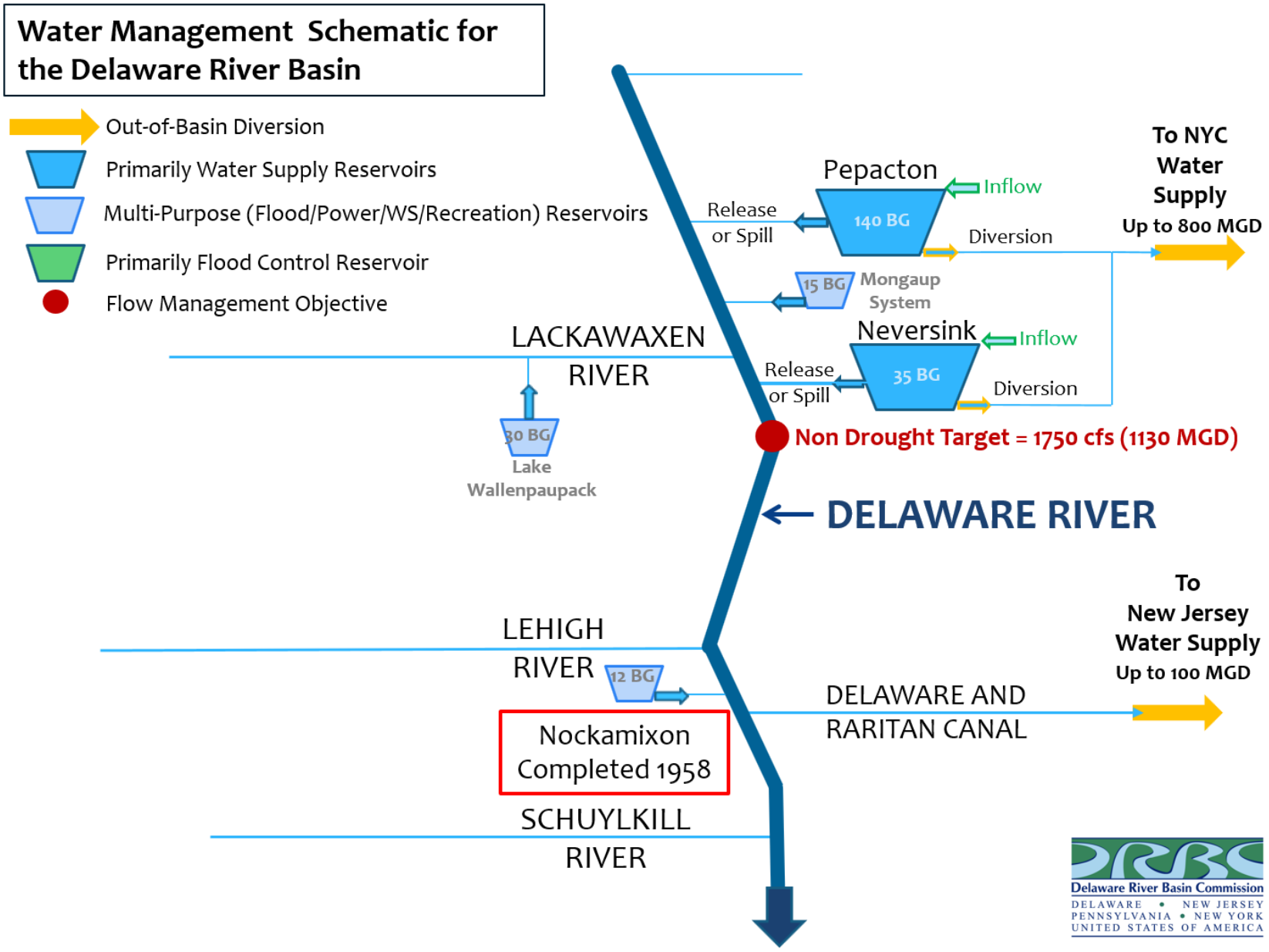

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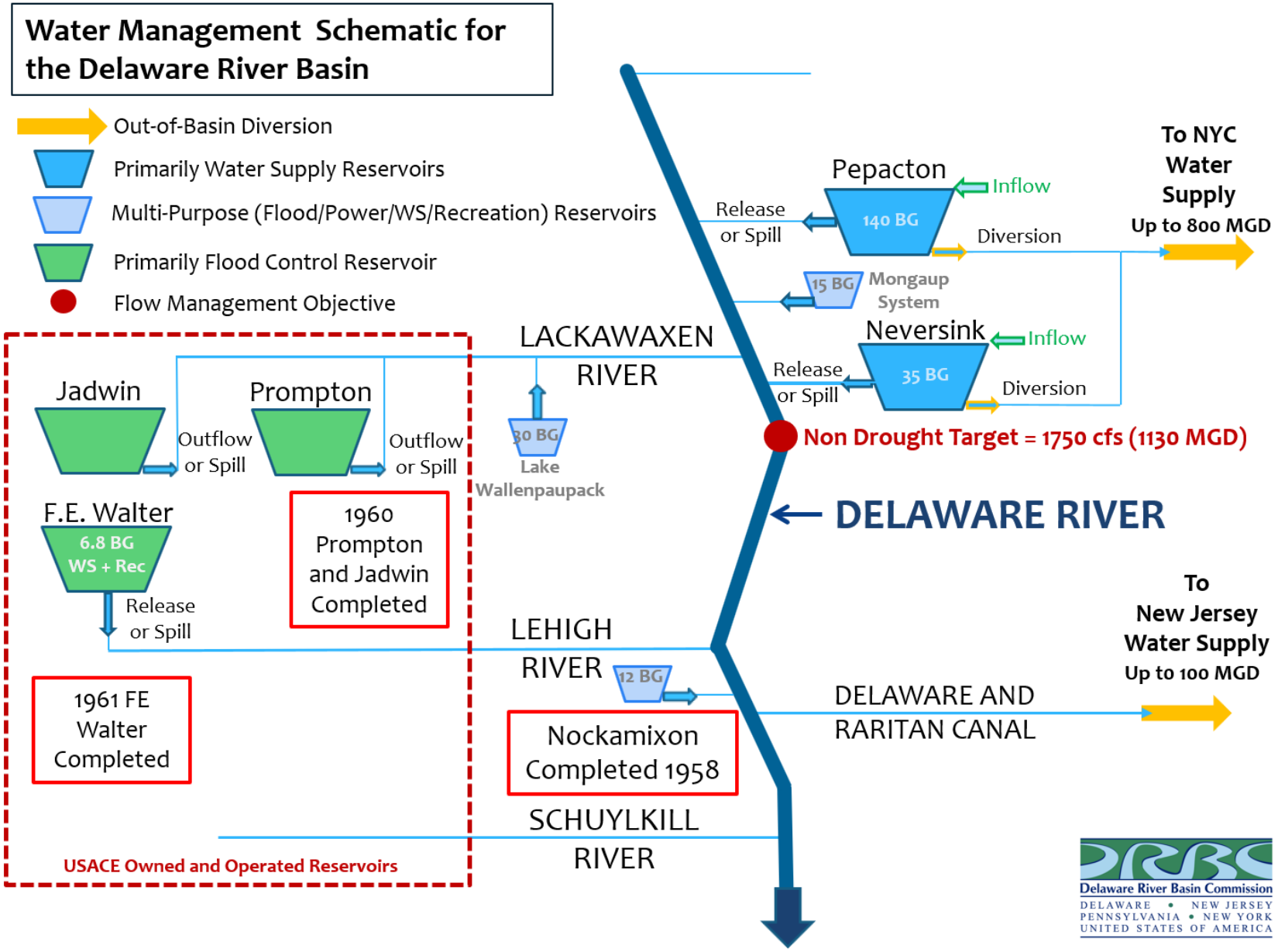
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Primarily Flood Control Reservoir
Flow Management Objective
Jadwin
Outflow or Spill
Prompton
Outflow or Spill
F.E. Walter
6.8 BG
WS + Rec
Release or Spill
1960 Prompton and Jadwin Completed
1961 FE Walter Completed
USACE Owned and Operated Reservoirs
LACKAWAXEN RIVER
30 BG
Lake Wallenpaupack
LEHIGH RIVER
12 BG
Nockamixon Completed 1958
SCHUYLKILL RIVER
Pepacton
Inflow
140 BG
Release or Spill
Diversion
15 BG
Mongaup System
Neversink
Inflow
35 BG
Release or Spill
Diversion
To NYC Water Supply
Up to 800 MGD
Non Drought Target = 1750 cfs (1130 MGD)
DELAWARE RIVER
To New Jersey Water Supply
Up to 100 MGD
DELAWARE AND RARITAN CANAL
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What Happened in 1961?

FOUR STATES SIGN DELAWARE PACT

President Joins in Approving Vast Program for Basin Backed by Governors

COMMISSION IS SET UP

Developing of River Valley Will Use, Conserve and Protect Vital Supply

By RUSSELL BAKER
Special to The New York Times.

(seated left to right) Governors Robert Meyner of New Jersey, Elbert Carvel of Delaware, and David Lawrence of Pennsylvania joined President John F. Kennedy at the White House on November 2, 1961, to participate in a ceremonial signing of the compact.

Commission

* Established by Compact in 1961 to address:
  * Water supply shortages – venue for cooperation
  * Serious flooding
  * Severe pollution in the main stem and major tributaries
* Authorized to change provisions of the 1954 Supreme Court Decree only **WITH** the unanimous consent of the parties
* Required to cooperate and collaborate with States and Federal Agencies

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1960s - Drought

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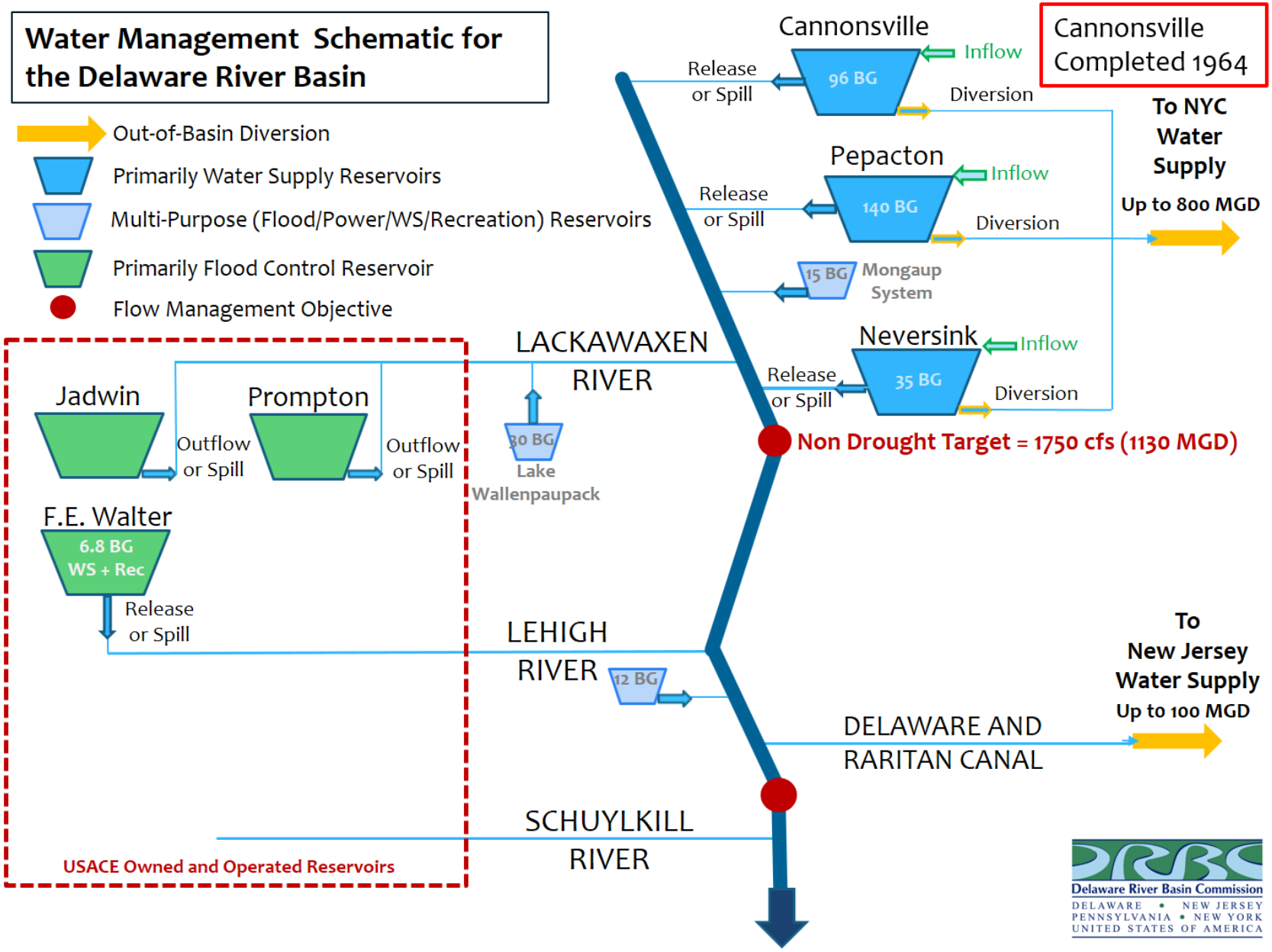
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Cannonsville
Cannonsville Completed 1964
Release or Spill
96 BG
Inflow
Diversion
To NYC Water Supply
Up to 800 MGD
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LEHIGH RIVER
12 BG
To New Jersey Water Supply
Up to 100 MGD
DELAWARE AND RARITAN CANAL
SCHUYLKILL RIVER
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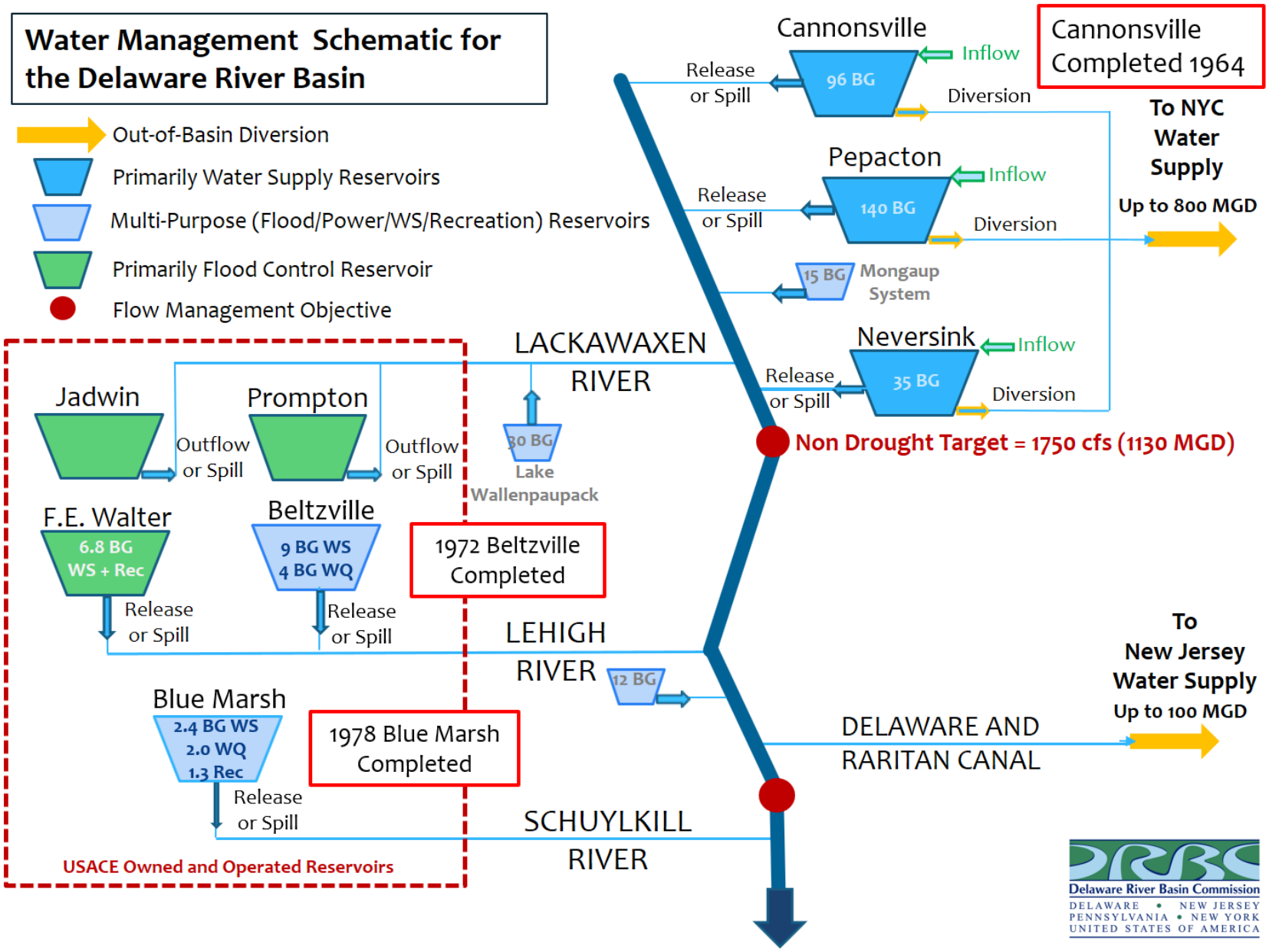
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Jadwin
Outflow or Spill
Prompton
Outflow or Spill
F.E. Walter
6.8 BG
WS + Rec
Release or Spill
Beltzville
9 BG WS
4 BG WQ
Release or Spill
1972 Beltzville Completed
LEHIGH RIVER
12 BG
Blue Marsh
2.4 BG WS
2.0 WQ
1.3 Rec
Release or Spill
1978 Blue Marsh Completed
DELAWARE AND RARITAN CANAL
To New Jersey Water Supply
Up to 100 MGD
SCHUYLKILL RIVER
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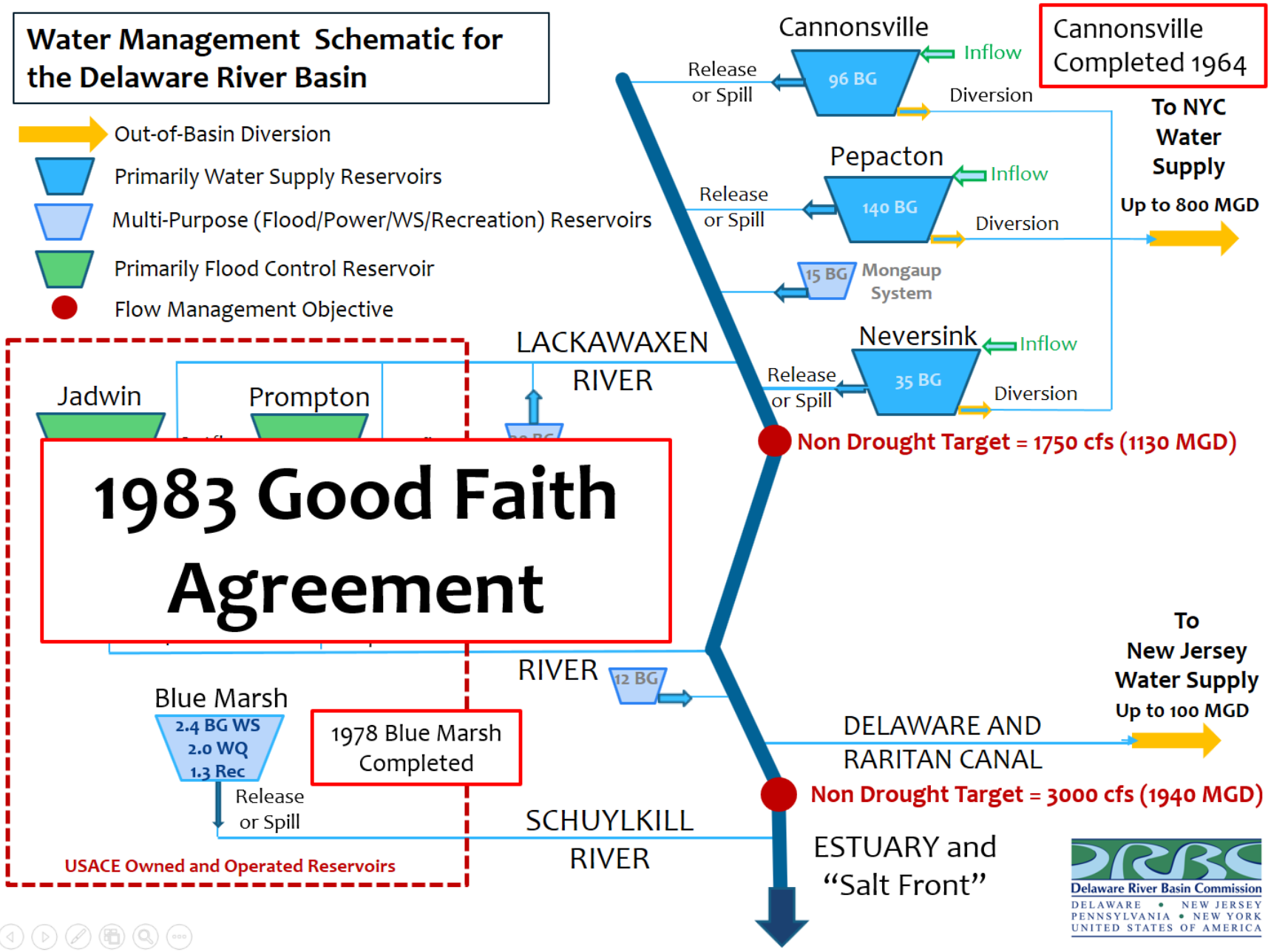
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LACKAWAXEN RIVER
Jadwin
Prompton
1983 Good Faith Agreement
RIVER
12 BG
To New Jersey Water Supply
Up to 100 MGD
DELAWARE AND RARITAN CANAL
Non Drought Target = 3000 cfs (1940 MGD)
Blue Marsh
2.4 BG WS
2.0 WQ
1.3 Rec
1978 Blue Marsh Completed
Release or Spill
SCHUYLKILL RIVER
ESTUARY and "Salt Front"
USACE Owned and Operated Reservoirs
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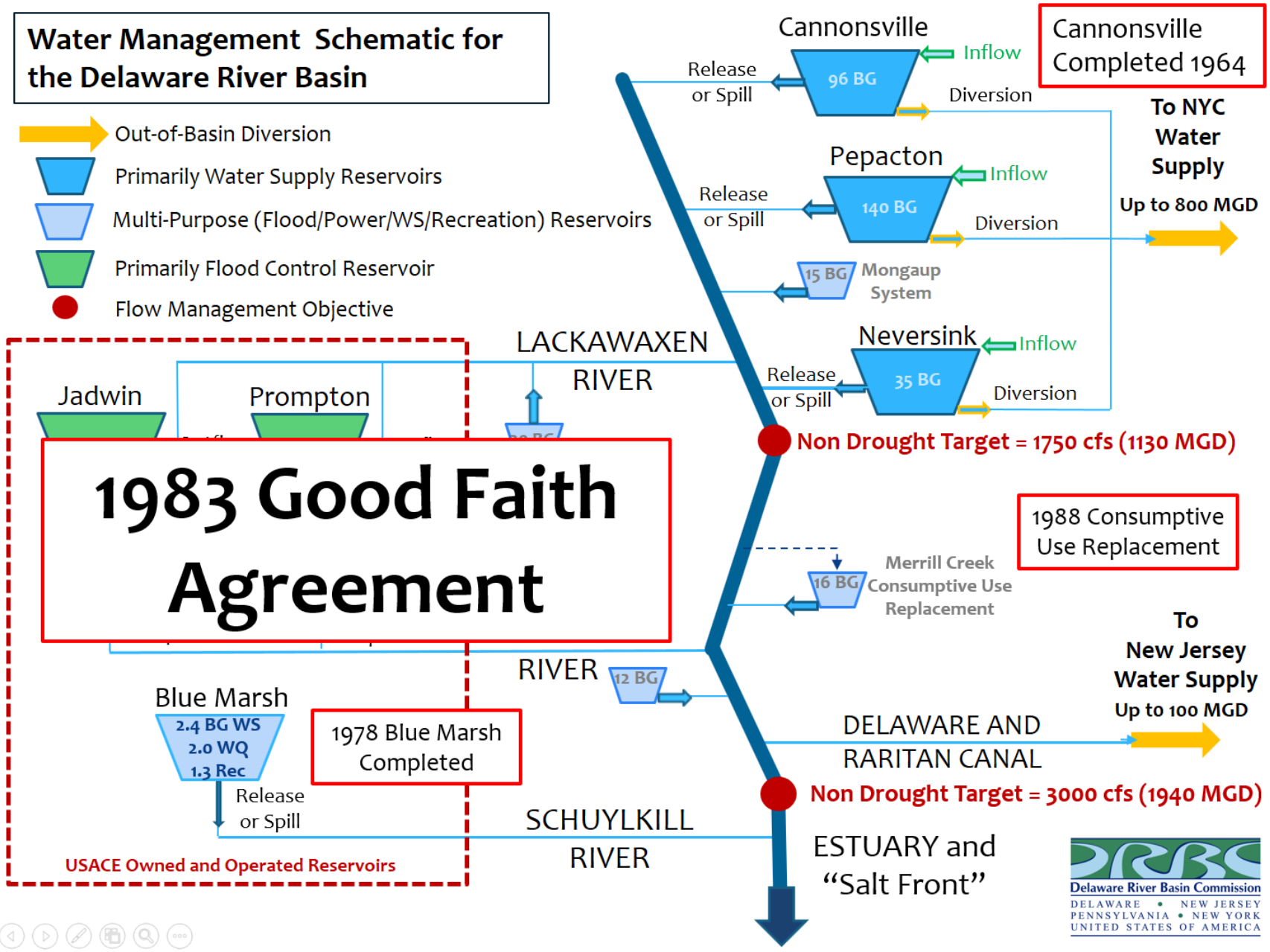
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35 BG
Diversion
LACKAWAXEN RIVER
Jadwin
Prompton
1983 Good Faith Agreement
Non Drought Target = 1750 cfs (1130 MGD)
1988 Consumptive Use Replacement
16 BG
Merrill Creek Consumptive Use Replacement
To New Jersey Water Supply
Up to 100 MGD
RIVER
12 BG
Blue Marsh
2.4 BG WS
2.0 WQ
1.3 Rec
1978 Blue Marsh Completed
Release or Spill
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ESTUARY and "Salt Front"
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Good Faith Agreement

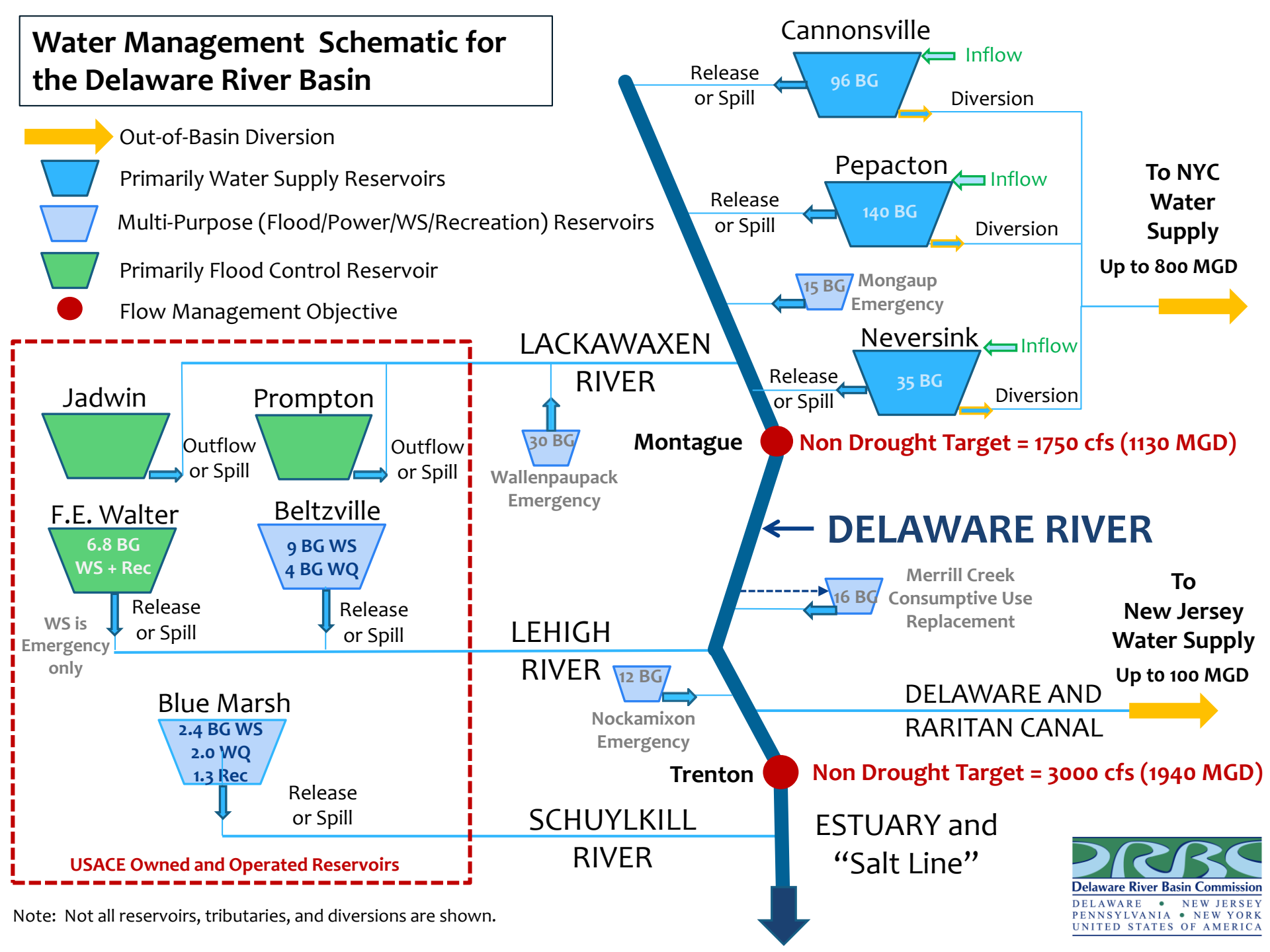
* Phased reductions in out-of-basin diversions by New York and New Jersey based on reservoir storage
* Phased reductions in flow objectives
* A new flow objective at Trenton
  * Ensures freshwater flow into estuary
  * Varies seasonally
* Drought Management Plans

Flexible Flow Management Program

* Bases the amount of water available for non-water supply purposes on current storage conditions and weather predictions from the national weather service.
* Beneficial uses include:
  * Enhanced releases for fisheries
  * Thermal mitigation
  * Spill mitigation

Converts spilled water into managed water.

Water Management Schematic for the Delaware River Basin



Note: Not all reservoirs, tributaries, and diversions are shown.

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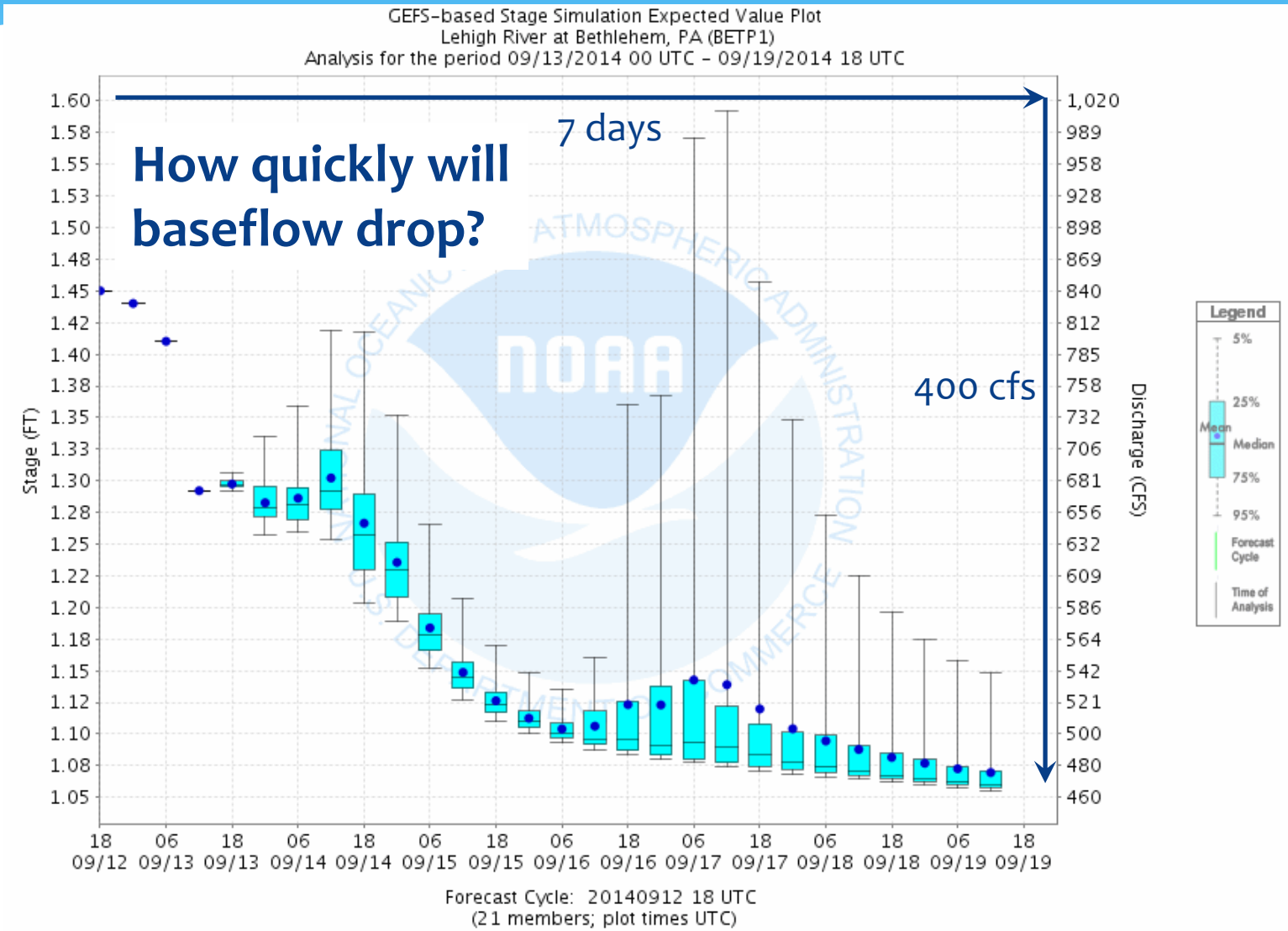
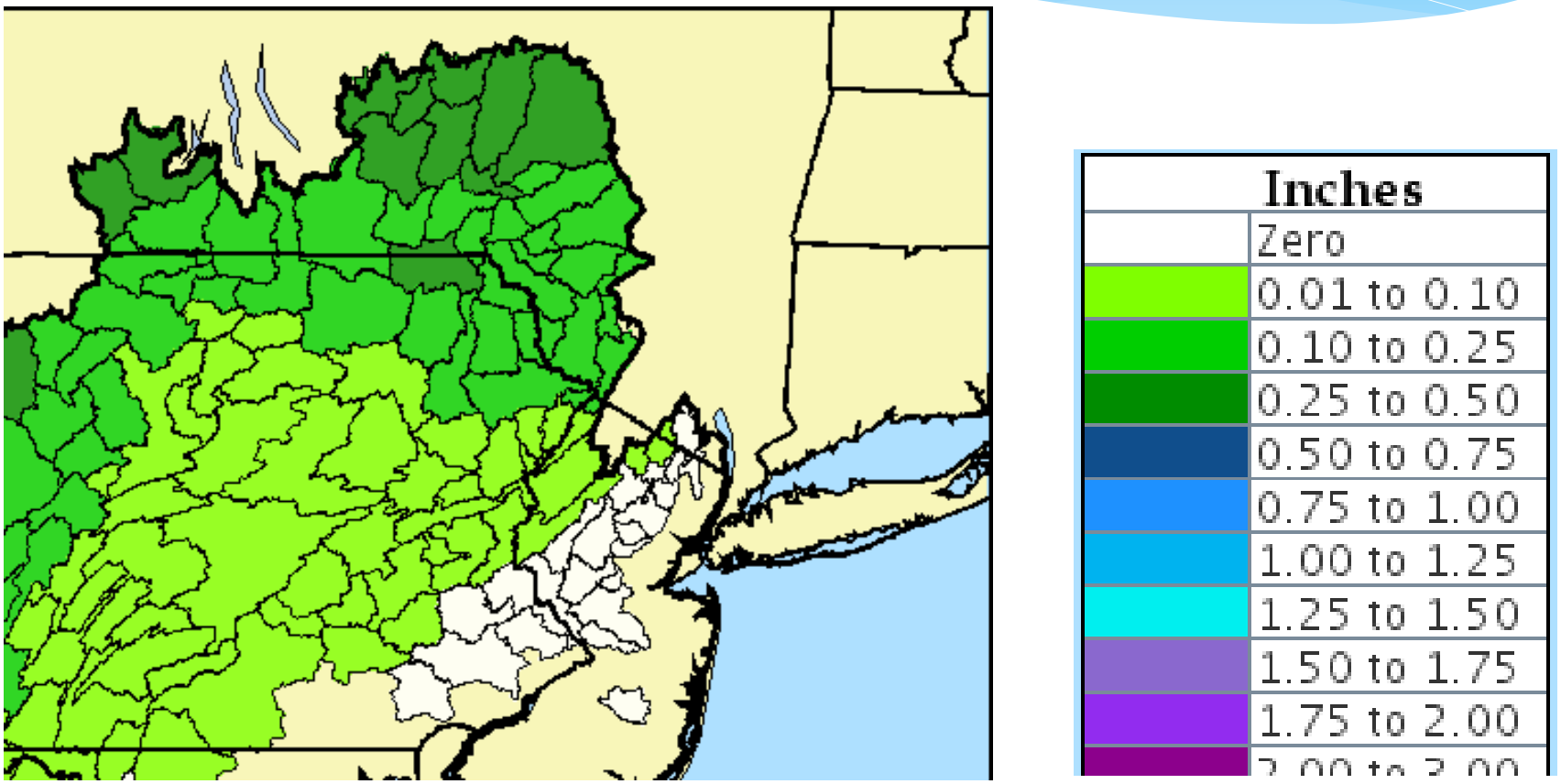
Designing Reservoir Releases

* USGS Gages
* River Master's Office (Montague)
  * Balancing Adjustment (over/under adjustments)
  * Post-Release Montague Prediction
  * Hydropower changes to schedule
* Quantitative Precipitation Forecasts (Day 1, Day 2, Day 3, Days 1-2, Days 1-3, Days 4-5, Days 6-7 and 5- and 7-day totals)
* Observed Precipitation
* Meteorologic Model Ensemble River Forecasts (MMEFS)
  * Flow
  * Precipitation

Baseflow Recession



Precipitation

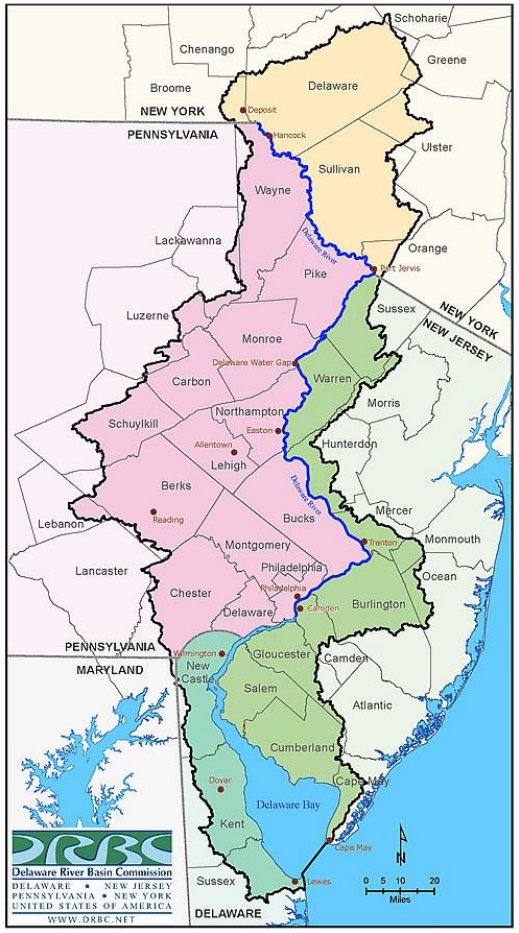


Credit: National Weather Service

Runoff

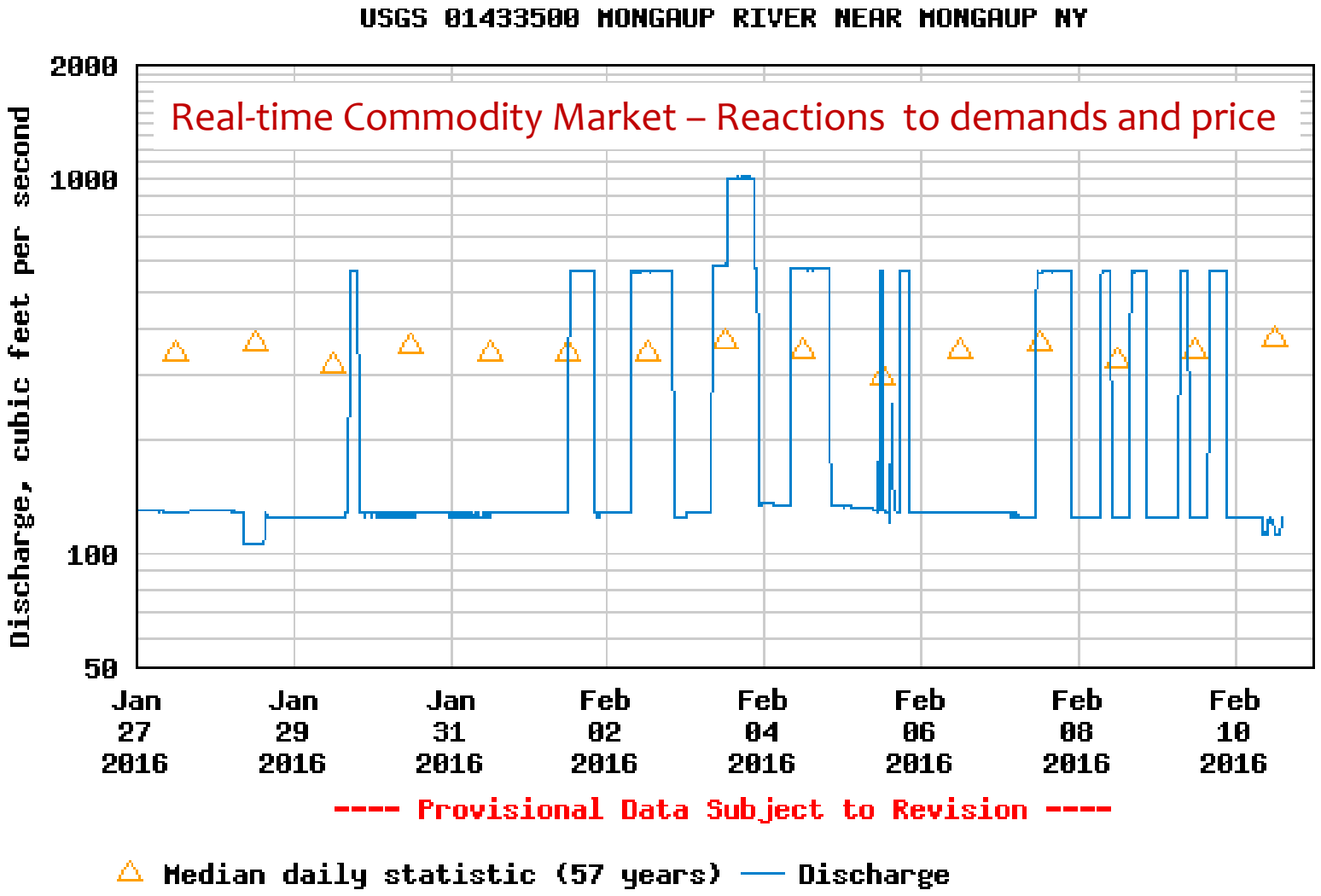
If you do not see water flowing into storm drain, it will not make it into the river.

Travel Times

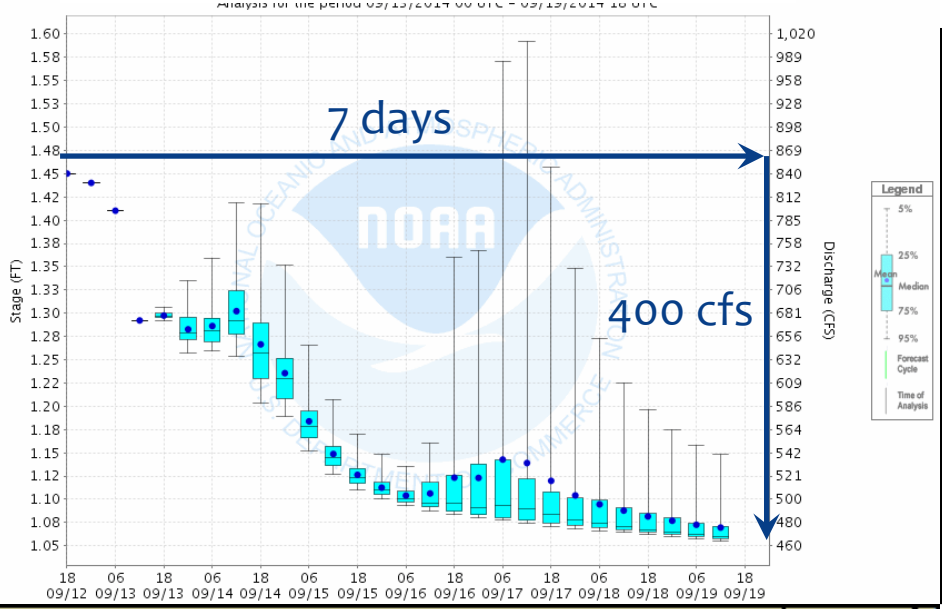


Reservoir	To Montague	To Trenton
Cannonsville	48 hours	96 hours
Pepacton	60 hours	108 hours
Neversink	33 hours	84 hours
Prompton	48 hours	96 hours
Wallenpaupack	16 hours	64 hours
Mongaup	8 hours	56 hours
FE Walter		60 hours
Beltzville		48 hours
Merrill Creek		24 hours
Nockamixon		12 hours
Blue Marsh		38 hours (Estuary)

Hydropower


USGS 01433500 MONGAUP RIVER NEAR MONGAUP NY
Real-time Commodity Market – Reactions to demands and price
Discharge, cubic feet per second
2000
1000
100
50
Jan 27 2016
Jan 29 2016
Jan 31 2016
Feb 02 2016
Feb 04 2016
Feb 06 2016
Feb 08 2016
Feb 10 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (57 years)
Discharge

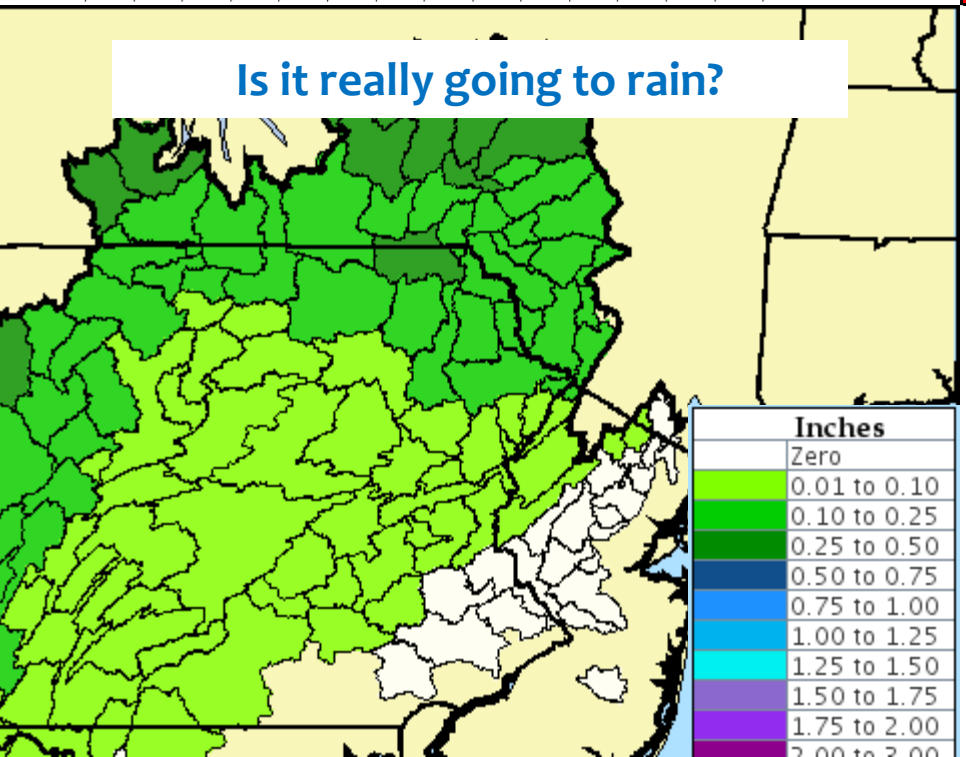
How quickly will baseflow drop?



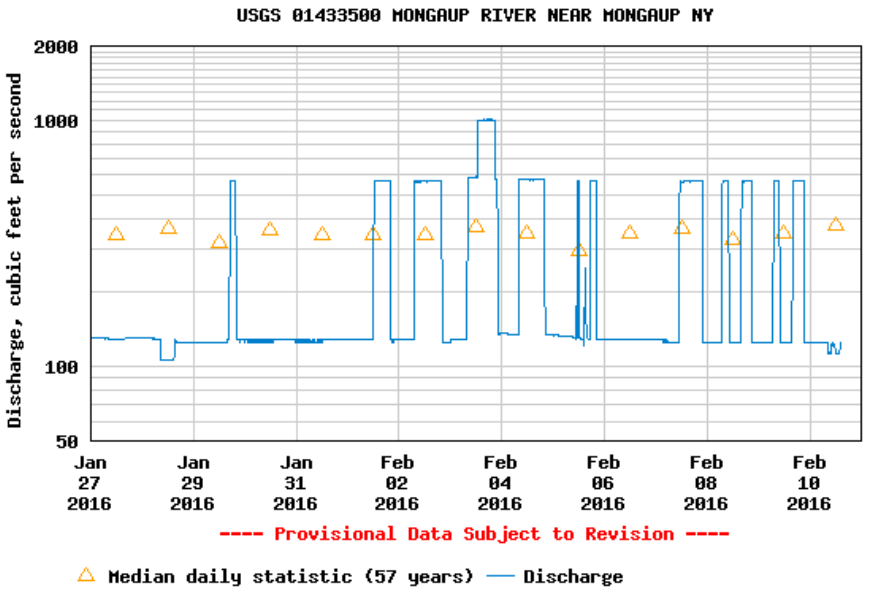
Will it get there on time?

Approximate Travel Times During Low Flow Conditions				
	Hours		Days	
	Montague	Trenton	Montague	Trenton
Cannonsville	48	96	2	4
Pepacton	60	108	2.5	4.5
Neversink	33	84	1.4	3.5
Wallenpaupack	16	64	0.7	2
Rio	8	56	0.3	2
Merrill Creek		24		1
FE Walter	44	60		2.5
Beltzville		32		2
Nockamixon		12		0.5
	Philadelphia			
Blue Marsh		38		

Is it really going to rain?



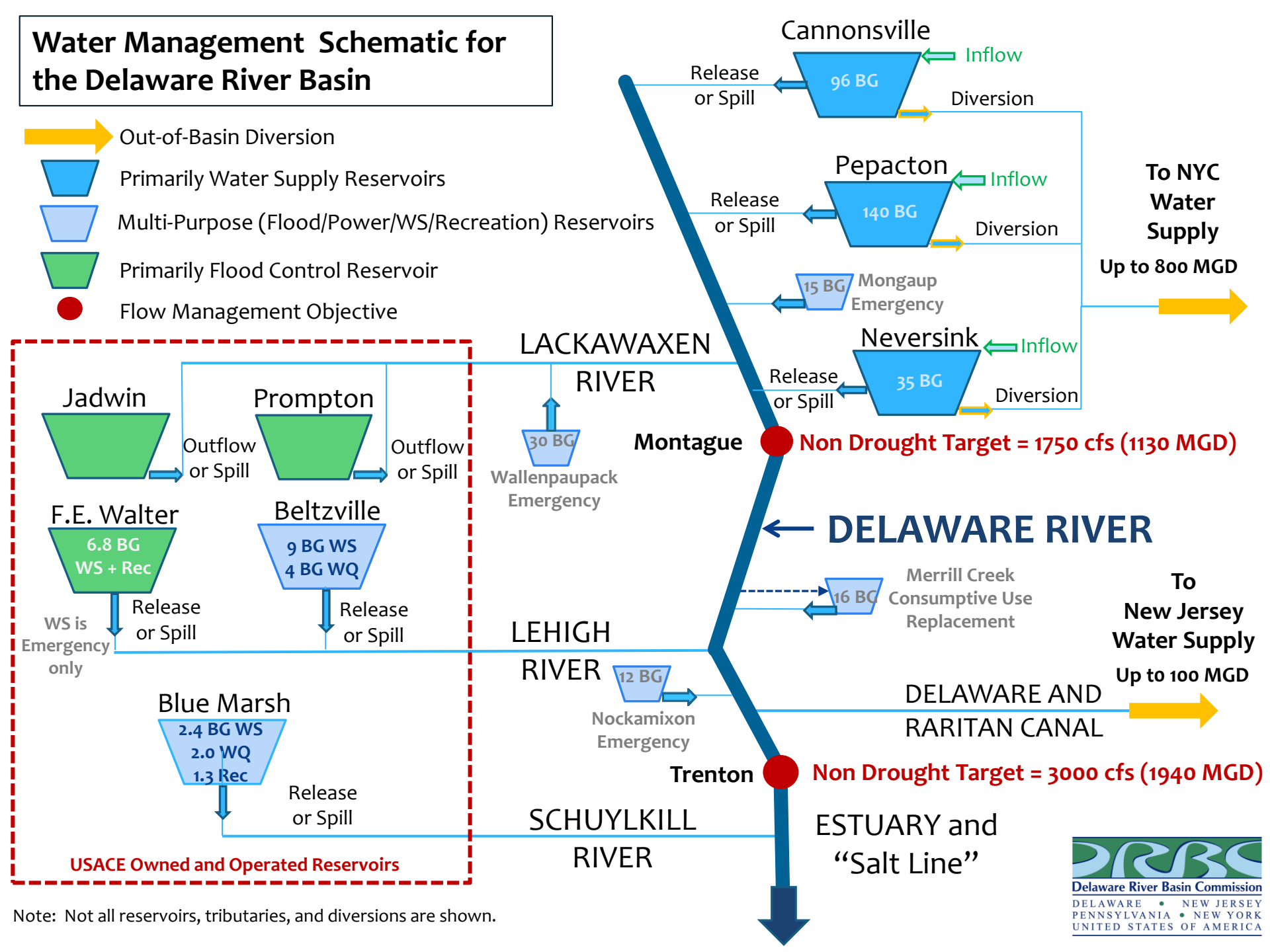
Will scheduled hydropower release occur?



Water Resource Management
in the DRB

* System developed over a long time with competing objectives
* Finite resources (water and storage)
* Operations can be designed to:
  * Use the resource when available
  * Conserve the water when becoming scarce
  * Be more drought resilient
* Uncertainties in real-time management – some irreducable
* Future uncertainties: *today could be the first day of the next drought of record*

Water Management Schematic for the Delaware River Basin



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Questions

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